GEOTECHNICAL ENGINEERING REPORT
LYON CREEK BRIDGE REPLACEMENT
BURKE GILMAN TRAIL
LAKE FOREST PARK, WASHINGTON

PROJECT NO. 81052367
JULY 7, 2008

Prepared for:

MACLEOD RECKORD
231 SUMMIT AVENUE EAST
SEATTLE, WA 98102

Prepared by:

ZZA-Terracon

18905 33rd Avenue West, Suite 117
Lynnwood, Washington 98036

July 17, 2008

MacLeod Reckord
231 Summit Avenue East
Seattle, Washington 98102

Attention: Mr. Terry Reckord

Subject: Geotechnical Engineering Report
Lyon Creek Bridge Replacement
Burke Gilman Trail
Lake Forest Park, Washington
ZZA-Terracon Project No.: 81052367

Dear Mr. Reckord,

The enclosed report contains the results of our field exploration, laboratory testing and geotechnical engineering analyses for the Lyon Creek Bridge Replacement project in Lake Forest Park, Washington. These services were completed in general accordance with the scope of work described in the Professional Services Agreement Contract dated January 23, 2006, and Contract Amendment No. 1 dated November 22, 2006. The information in this report is based on our understanding of the proposed bridge replacement project, and the soil and groundwater conditions encountered in borings completed at the site on May 21, 2007.

We recommend that the project plans and specifications be submitted to ZZA-Terracon for a general review to confirm that the recommendations in this report are interpreted and implemented properly in the construction documents. We recommend that a representative from our firm be present during the geotechnical portions of project construction to confirm that the soil and groundwater conditions are consistent with those that form the basis for the engineering recommendations in this report.

We appreciate the opportunity to provide these services. Please call if you have any questions.

Respectfully Submitted,

ZZA-Terracon

James B Thompson

James B. Thompson, P.E.
Senior Principal

JAMES B. THOMPSON
STATE OF WASHINGTON
19409
REGISTERED
PROFESSIONAL ENGINEER

7/17/08

EXPIRES 04 / 03 / 10

GEOTECHNICAL ENGINEERING REPORT

PROPOSED LYON CREEK BRIDGE REPLACEMENT
BURKE GILMAN TRAIL
LAKE FOREST PARK, WASHINGTON

ZZA-Terracon Project No. 81052367
July 17, 2008

INTRODUCTION

This report summarizes the results of our geotechnical evaluation for the proposed Lyon Creek Bridge replacement along the segment of the Burke Gilman Trail within Lake Forest Park, Washington. These services were completed in general accordance with the scope of work described in the Professional Services Agreement Contract dated January 23, 2006, and Contract Amendment No. 1 dated November 22, 2006. Our scope of services included field explorations, laboratory testing, geotechnical engineering analyses, and preparation of this report.

PROJECT DESCRIPTION

The project plans include demolition of the existing Lyon Creek Bridge, and construction of a new bridge. As shown in Figure 1, the new bridge will be constructed at approximately the same location as the existing bridge, except that the new bridge will be longer. We understand that future trail grades at the bridge abutments will be approximately the same as existing grades.

We understand that the new bridge will be a single-span structure supported on cast in place concrete abutments. The bridge will be approximately 14 feet wide and 62 feet long. Cast in place concrete wing walls are planned at both abutments to retain the approach embankments.

The existing bridge has timber abutments which will be demolished. We understand that the location and configuration of the existing creek channel might be modified. Several measures are being considered to protect the new stream channel against scour including riprap.

SURFACE CONDITIONS

The project site is located along the Burke Gilman Trail approximately 300 feet west of Ballinger Way. East and west of the bridge, the creek flows in an east-northeast direction parallel to the trail. The creek turns abruptly to the southeast where it passes beneath the bridge. The existing bridge has timber abutments. In addition, an existing retaining wall is located on the south bank of the creek west of the bridge.

SUBSURFACE CONDITIONS

Field Exploration & Laboratory Testing

Subsurface conditions at the project site were evaluated by completing two borings on May 21, 2007 using a track-mounted hollow stem auger drill rig. The approximate locations of the borings are shown on Figure 1, Site and Exploration Plan. The field exploration procedures and logs of the borings are presented in Appendix A.

Soil samples were collected from the borings and placed in sealed containers for further examination and laboratory testing. Selected samples were tested for moisture content and grain size analysis. The laboratory testing procedures and results are presented in Appendix B.

Soil Conditions

Probable fill was encountered to depths of 5.5 and 6.0 feet in Borings B-1 and B-2, respectively. In Boring B-1, the probable fill consisted of loose silty sand. In Boring B-2, the probable fill consisted of loose, poorly graded sand with gravel and silt.

Native deposits typically consisting of medium dense to dense sand with varying amounts of silt and gravel were encountered below the probable fill. The native deposits also included layers of stiff to very stiff silty clay and clayey silt.

Water Level Observations

Groundwater levels are generally expected to be at or close to creek levels.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Based on the subsurface conditions encountered at the exploration locations, it is our opinion that the site is suitable for construction of the proposed Lyon Creek bridge replacement. It is our opinion that the new bridge can be supported on conventional spread footings. Specific conclusions and recommendations concerning seismic considerations, site preparation, foundation considerations, lateral resistance, lateral soil pressures, and rock riprap are discussed in the following sections.

SEISMIC CONSIDERATIONS

Geotechnical earthquake engineering input for development of the general design response spectrum of the International Building Code 2006 requires a site class definition and short period (S_s) and 1-second period (S_1) spectral acceleration values. The USGS

National Seismic Hazard Mapping Project (http://eqhazmaps.usgs.gov/) computes the 2002 spectral ordinates (5 percent damping) at building periods of 0.2 and 1.0 seconds for ground motions at the project site with a 2 percent probability of exceedance in 50 years as 1.23g and 0.42g. Therefore, we recommend for the 2006 IBC that S_s and S_1 be assigned values of 1.23g and 0.42g, respectively. Based on the subsurface conditions encountered at the site and published geologic literature, we estimate that the average properties of the upper 100 feet of the site profile correspond to Site Class D. This designation describes soils that are considered very dense with a shear wave velocity of 600 to 1,200 feet per second, Standard Penetration Test values of 15 to 50, and an undrained shear strength of 1,000 to 2,000 psf.

Liquefaction is the phenomenon wherein soil strength is reduced when subjected to vibration or shaking. Liquefaction generally occurs in saturated, loose sand deposits. Based on site geology and subsurface conditions encountered at our boring locations, the foundations for the new bridge will be underlain by native deposits typically consisting of medium dense to dense sand with varying amounts of silt. The native deposits also include layers of stiff to very stiff silty clay and clayey silt. The results of our analyses indicate that the liquefaction potential of the native soil deposits is low.

SITE PREPARATION

General

We understand that site preparation for construction of the new bridge will include demolition of the existing structure including the timber abutments.

Temporary Open-Cut Slopes

We anticipate that the majority of the excavations for the new bridge will be made as open cuts. The stability of open-cut slopes is a function of soil type, ground water levels, slope inclination, and nearby surface loads. The use of inadequately designed open-cuts could impact the stability of adjacent site improvements and endanger personnel. In our opinion, the contractor will be in the best position to observe subsurface conditions on a continuous basis throughout the construction process, and to respond to changes in soil and groundwater conditions. As a result, the contractor should have the primary responsibility for deciding whether or not to use an open-cut rather than some form of temporary excavation support.

Based on Chapter 296-155, Part N, Excavation Trenching and Shoring, of the Washington Administrative Code (WAC), it is our opinion that the fill and native soils meet the criteria for a Type C soil. According to the Code, excavations less than 20 feet deep in Type C soils may be cut at a maximum temporary slope angle of 34 degrees (1½H:1V). These guidelines assume that the excavation is adequately dewatered and that surface loads, such as equipment loads and storage loads, will be kept a sufficient distance away from the top of the cut so that the stability of the excavation is not affected. Flatter temporary cut slopes may be required in the presence of groundwater seepage.

It should be expected that the excavation face will experience some sloughing and raveling. Berms, swales, or drainage ditches should be installed around the perimeter of the excavation to intercept surface runoff and reduce the potential for sloughing and erosion of the cut face. All temporary slopes should be covered with plastic sheeting during periods of wet weather to reduce the potential for erosion.

Construction Dewatering

Based on our subsurface explorations, we anticipate that groundwater may be encountered within the project excavations. We recommend that all project excavations be adequately dewatered so that work can be performed in the "dry." To maintain a stable base on which to construct the bridge foundations, we recommend that groundwater levels temporarily be maintained at least 2 feet below the finished subgrade surface in footing areas.

In our opinion, the contractor should be responsible for designing and installing an appropriate dewatering system as needed to complete the work. The dewatering plan should include provisions for disposal of the collected water.

FOUNDATION CONSIDERATIONS

The new bridge can be supported on conventional spread footings. The spread footings should be founded directly on the medium dense to dense native sand encountered at a depth of 10 feet in Borings B-1 and B-2, or on a zone of structural fill which extends down to the medium dense to dense sand. The structural fill should consist of material which meets the requirements for WSDOT 9-03.14(1) Gravel Borrow. The zone of Gravel Borrow should extend laterally beyond the edge of the footing a distance at least equal to its thickness below the footing. The Gravel Borrow should be compacted to a firm and nonyielding condition, and to at least 95 percent of the maximum dry density determined in accordance with the ASTM D-1557 test procedure.

We recommend that spread footings for the new bridge have a minimum width of 3 feet and a minimum depth of embedment below lowest adjacent finished grade of 18 inches for frost protection. Spread footings founded on the medium dense to dense native sand, or on a zone of Gravel Borrow, as described above may be proportioned using a maximum allowable bearing capacity of 3,000 pounds per square foot for static conditions. This allowable value may be increased by one-third for short-term loading conditions such as wind or seismic forces.

We estimate that post-construction settlement of spread footings, founded as recommended, will be less than 1-inch with less than ½-inch of differential settlement along the length of the footing. These settlements are expected to occur over an extended period of time.

The soils exposed in the base of the footing excavations and the placement of the Gravel Borrow should be observed by a representative of our firm to confirm that suitable bearing conditions are achieved.

LATERAL RESISTANCE

The soil resistance available to resist lateral foundation loads is a function of the frictional resistance which can develop on the base and the passive resistance which can develop on the face of below-grade elements of the structure as these elements tend to move into the soil. For conventional spread footings founded on the medium dense to dense native sand or compacted Gravel Borrow, the frictional resistance may be computed using an allowable friction coefficient of 0.35 applied to the vertical dead-load forces. Passive resistance may be computed using equivalent fluid densities of 275 and 135 pcf above and below the water table, respectively, for a level ground surface; these values are applicable to the soils located behind the abutments. Passive resistance for the soils located on the creek side of the abutment will be relatively small due to the sloping ground surface and should be ignored. The above allowable coefficient of friction and passive resistance values include a factor of safety of about 1.5.

LATERAL SOIL PRESSURES

The lateral soil pressures acting on abutment walls will depend on the nature and density of the soil behind the wall, and the amount of lateral wall movement that can occur as backfill is placed. For walls that are free to yield at the top at least one-thousandth of the height of the wall, soil pressures will be less than if movement is limited by such factors as wall stiffness or bracing.

Assuming that the walls are adequately drained to prevent the buildup of hydrostatic pressures, we recommend that yielding walls supporting horizontal backfill be designed using an equivalent fluid density of 35 pcf (pounds per cubic foot). Non-yielding walls should be designed using an equivalent fluid density of 60 pcf.

If adequate drainage is **not** provided to prevent the buildup of hydrostatic pressures, we recommend that yielding walls supporting horizontal backfill be designed using an equivalent fluid density of 80 pcf (20 pcf soil and 60 pcf water). Non-yielding walls should be designed using an equivalent fluid density of 90 pcf (30 pcf soil and 60 pcf water).

Based on site conditions and input for a design seismic event with a 2 percent probability of exceedance in 50 years as specified in the 2006 International Building Code, we recommend that a uniform seismic surcharge equal to 7H and 11H in pounds per square foot (rectangular distribution) be used in wall design for active and at rest conditions, respectively, where H is the height of the abutment wall in feet.

The above recommended lateral soil pressures do not include the effects of sloping backfill surfaces or surcharges such as traffic loads or other surface loading. Sloping backfill and surcharge effects should be considered as appropriate.

To achieve the lower wall pressures described above for the drained case, adequate drainage measures must be installed to collect and direct subsurface water away from the abutment walls. To minimize lateral earth pressures and prevent the buildup of hydrostatic pressures, the backfill within 24 inches of the abutment should consist of coarse sand and gravel meeting the requirements of WSDOT 9-03.12(4) Gravel Backfill for Drains. A 6-inch diameter, rigid wall, perforated drain pipe should be installed at the base of the drain zone. At appropriate intervals such that water backup does not occur, the drainpipe should be connected to a tightline system leading to a suitable discharge. Cleanouts should be provided for future maintenance. As an alternative to installation of the drain pipe, weep holes may be utilized to drain the granular backfill for the abutments.

Bridge abutment backfill should consist of material meeting the requirements of WSDOT 9-03.12(2) Gravel Backfill for Walls. The backfill should be compacted to at least 95 percent of the maximum dry density determined in accordance with the ASTM D-1557 test method. Measures should be taken to prevent the buildup of excess lateral pressures due to overcompaction of the backfill behind the abutment wall. This can be accomplished by placing the backfill located within 24 inches of the wall in lifts not exceeding 6 inches in loose depth and compacting with hand-operated or self-propelled equipment. An approximately 1-foot thick layer of impervious soil should be placed atop the backfill to inhibit surface run-off from entering the wall backfill.

ROCK RIPRAP

It is important that appropriate measures be taken to protect the bridge abutments, and the banks and bed of the creek near the bridge, against scour. Measures which are often considered include, but are not limited to, biological countermeasures, loose rock riprap, grouted rock riprap, cast-in-place concrete revetments, and prefabricated concrete units and mats.

ZZA Terracon has completed an evaluation of the use of loose rock riprap armor for the Lyon Creek bridge location in general accordance with the design guidelines presented in the 2001 FHWA publication *Bridge Scour and Stream Instability Countermeasures* (Hydraulic Engineering Circular No. 23). Our analysis was based, in part, on the following information provided to ZZA Terracon by others.

- A minimum stream bed width of 5 feet.
- A maximum stream bank slope inclination of 2H:1V.
- A maximum stream bed slope inclination of 3 percent.
- A design stream discharge rate of 200 cubic feet per second (cfs) based on a 2008 instantaneous discharge rate of about 187 cfs. It is not clear what flood event is

represented by the 187 cfs discharge rate. We understand that discharge rates for 100 and 500 year flood events were not available.

- Tight radius stream curves near the upstream and downstream sides of the bridge.

Based on our analyses, we recommend that the bed and banks of the stream at the bridge location be protected by an apron of well graded light loose riprap meeting 2008 WSDOT *Standard Specifications,* Section 9-13.1(2), amended so that at least 50 percent of the material by weight is at least 1.2 cubic feet in size or about 180 pounds. We recommend a minimum thickness of 2 feet for the riprap apron. The riprap armor should extend at least 2 feet above the maximum high water level in the creek. We recommend that the natural channel banks upstream and downstream of the bridge be similarly armored for a distance of at least 30 feet from the bridge.

We recommend that the riprap be underlain by a Class A, high survivability geotextile for permanent erosion control and ditch lining meeting 2008 WSDOT *Standard Specifications,* Section 9-33.2(1), Tables 4 and 5.

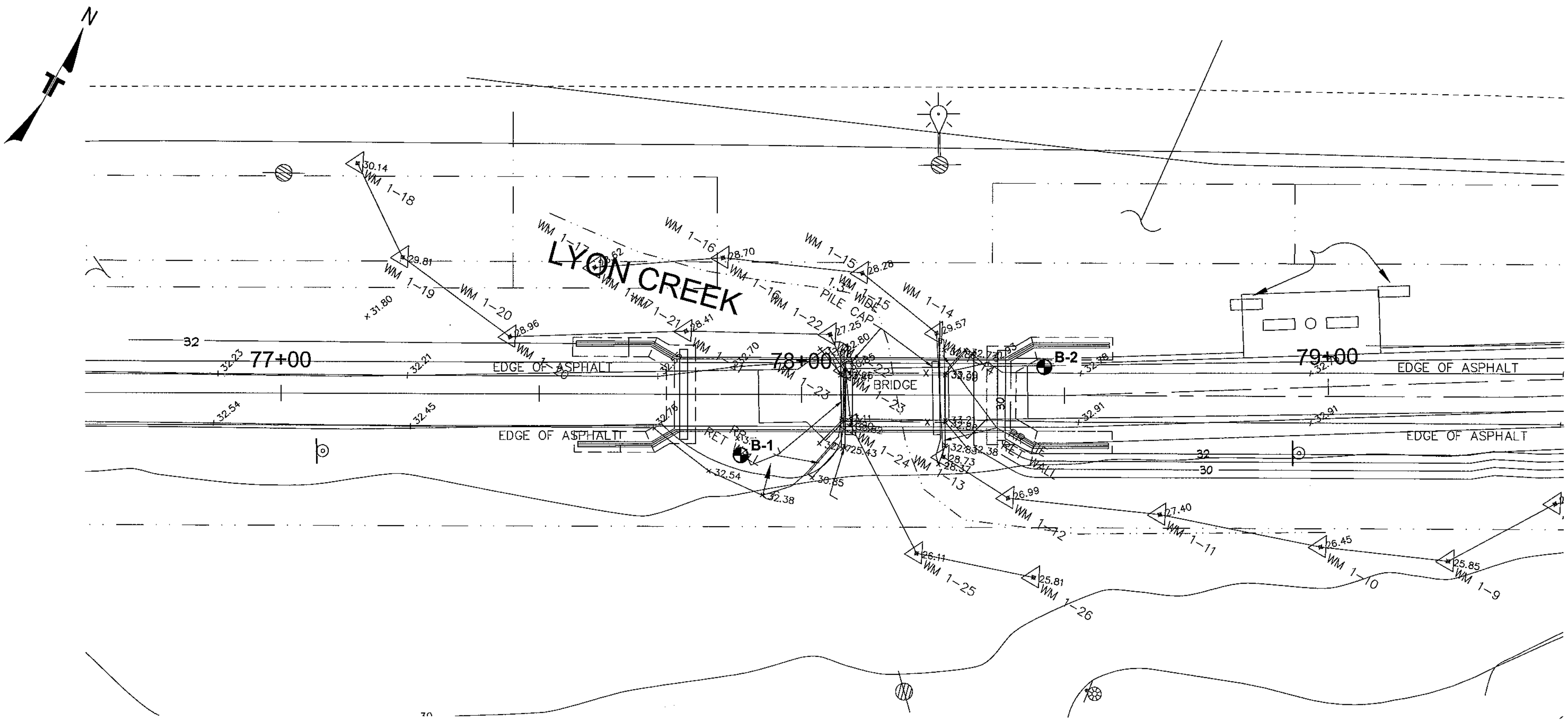
GENERAL COMMENTS

ZZA-Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. ZZA-Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the explorations performed at the indicated locations. This report does not reflect variations that may occur between explorations, across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for the project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of MacLeod Reckord for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices in this area at the time the report was prepared. No warranties, either expressed or implied, are intended or made. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless ZZA-Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.



LEGEND:

B-1 BORING NUMBER AND APPROXIMATE LOCATION

20 0 5 10 20
SCALE IN FEET

Basemap DWG file provided by MaCleod Reckord and modified by ZZA-TERRACON.

Project Mngr: JBT	Project No. 81052367	ZZA-Terracon Consulting Engineers and Scientists	**SITE AND EXPLORATION PLAN**
Drawn By: JD	Scale: AS SHOWN	18905 33rd Avenue West, Suite 117 Lynnwood, WA 98036	Lyon Creek Bridge Replacement Burke Gilman Trail
Checked By: JBT	File No. Fig1 Bridge.DWG	PH. (425) 771-3304 FAX. (425) 771-3549	Lake Forest Park, Washington
Approved By: JBT	Date: July, 2008		Prepared for: MaCleod Reckord

FIG. No. 1

APPENDIX A
81052367

FIELD EXPLORATION PROCEDURES AND LOGS

Our field exploration for the project included two geotechnical borings completed on May 21, 2007. The approximate exploration locations are shown on Figure 1, Site and Exploration Plan. Exploration locations were determined by measuring distances from existing site features by pacing or taping. As such, the exploration locations should be considered accurate only to the degree implied by the measurement method. The following sections describe our procedures associated with the explorations. Descriptive logs of the explorations are enclosed in this appendix.

The exploratory borings were advanced with a hollow stem auger using a trailer-mounted drill rig operated by an independent drilling company working under subcontract to ZZA. An engineering geologist from our firm continuously observed the borings, logged the subsurface conditions encountered, and obtained representative soil samples. All samples were stored in moisture-tight containers and transported to our laboratory for further visual classification and testing. Samples were obtained by means of the Standard Penetration Test throughout the drilling operation.

The Standard Penetration Test (ASTM: D-1586) procedure consists of driving a standard 2-inch outside diameter steel split spoon sampler 18 inches into the soil with a 140-pound hammer free falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is recorded, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or "blow count" (N value). If a total of 50 blows is struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed boring logs describe the vertical sequence of soils and materials encountered in each boring, based primarily upon our field classifications and supported by our subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the boring, as well as laboratory tests performed on these soil samples. If groundwater was encountered in a borehole, the approximate groundwater depth, and date of observation, are depicted on the log.

LOG OF BORING NO. B-1

CLIENT: **MacLeod Reckord**

SITE: **Lake Forest Park, Washington**

PROJECT: **Burke Gilman Trail**

Boring Location: Lyon's Creek Bridge

GRAPHIC LOG (depth)	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	
0.5	Grass over **SILTY SAND,** with abundant roots, dark brown, loose, moist to wet (Topsoil)									
	SILTY SAND, dark brown, loose, moist to wet (Probable Fill)									
5.5	grades to black	5	SP	1	SS	12	11	13		
	POORLY GRADED SAND, fine to medium with trace coarse, with silt, trace gravel, brown, medium dense, moist									
	grades to saturated, silty ▽									
		10	SM	2	SS	6	22			
	grades to trace silt, no gravel, dense	15	SP	3	SS	12	37			
	grades to with silt, trace gravel, medium dense	20	SP	4	SS	12	26	17		
25		25								

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft	
WL ▽ 8.0	WD ▼
WL ▼	▼
WL	WD - While Drilling

ZZA-Terracon
18905 33rd Avenue West, Ste. 117
Lynnwood, WA 98036
T: (425) 771-3304 F: (425) 771-3549

BORING STARTED	5-21-07		
BORING COMPLETED	5-21-07		
RIG	Volvo	CO.	Boretec
LOGGED	BAG	JOB #	81052367

LOG OF BORING NO. B-1

CLIENT	
MacLeod Reckord	
SITE Lake Forest Park, Washington	**PROJECT** Burke Gilman Trail

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	TYPE	RECOVERY, in.	SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	DRY UNIT WT pcf		
	grades to gravelly, dense		SP	5	SS	12	33				
	30.5	30	CL	6	SS	18	19				
	31 **SILTY CLAY,** with fine sand laminae, gray, very stiff, saturated										
	SILTY SAND, fine to medium, brown, medium dense, saturated										
	grades to trace gravel, dense	35	SM	7	SS	12	38				
	grades to medium dense	40	CL	8	SS	12	13				
	41										
	41.5 **SILTY CLAY,** laminated with fine sand, gray, stiff, saturated										
	SILTY SAND, brown, medium dense, saturated										
	46	45	CL	9	SS	12	17				
	46.5 **SILTY CLAY,** laminated with fine to coarse sand, gray, very stiff, saturated										
	SILTY SAND, brown, medium dense, saturated										
		50									

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	∇ 8.0	WD	▼
WL	∇		▼
WL	WD - While Drilling		

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BORING COMPLETED	5-21-07		
RIG	Volvo	CO.	Boretec
LOGGED	BAG	JOB #	81052367

LOG OF BORING NO. B-1

CLIENT: MacLeod Reckord	
SITE: Lake Forest Park, Washington	PROJECT: Burke Gilman Trail

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS:
51			SM	10	SS	18	15	20		
	SILTY CLAY, gray, stiff to very stiff, saturated	55	CL	11	SS	18	23			
61		60	SM	12	SS	12	46			
61.5	**SILTY SAND,** fine, gray and brown, dense, saturated **BOTTOM OF BORING**									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	∇ 8.0	WD ▼
WL	▼	▼
WL	WD - While Drilling	

ZZA-Terracon
18905 33rd Avenue West, Ste. 117
Lynnwood, WA 98036
T: (425) 771-3304 F: (425) 771-3549

BORING STARTED			5-21-07
BORING COMPLETED			5-21-07
RIG	Volvo	CO.	Boretec
LOGGED	BAG	JOB #	81052367

ZZA-TCI_BOREHOLE 81052367.GPI.GPJ TERRACON.GDT 6/30/08

LOG OF BORING NO. B-2

CLIENT: MacLeod Reckord	
SITE: Lake Forest Park, Washington	PROJECT: Burke Gilman Trail

Boring Location: Lyon's Creek Bridge

DEPTH (boundary)	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf		
0.3	3 inches **ASPHALT**										
6	**POORLY GRADED SAND WITH GRAVEL AND SILT,** brown, loose, moist to wet (Probable Fill)	5	SP SM	1	SS	12	6	12			
	POORLY GRADED SAND WITH SILT AND GRAVEL, fine to medium with trace coarse, brown, loose, saturated ∇										
	grades to medium dense	10	SP SM	2	SS	18	24	19			
	grades to trace silt, trace gravel	15	SP	3	SS	18	26				
		20	SP	4	SS	12	25				
25		25									

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	∇ 7.0	WD ▼
WL	▼	▼
WL	WD - While Drilling	

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Lynnwood, WA 98036
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BORING STARTED	5-21-07		
BORING COMPLETED	5-21-07		
RIG	Volvo	CO.	Boretec
LOGGED	BAG	JOB #	81052367

LOG OF BORING NO. B-2

CLIENT	
MacLeod Reckord	
SITE	PROJECT
Lake Forest Park, Washington	Burke Gilman Trail

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf		
	grades to silty, gray, dense		SM	5	SS	18	33				
	grades to with silt, brown	30	SP SM	6	SS	18	49				
	35.5	35	ML	7	SS	12	31				
	CLAYEY SILT, with trace sand, brown, very stiff, saturated										
	36.5										
	BOTTOM OF BORING										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	∇ 7.0	WD ▼
WL	▼	▼
WL	WD - While Drilling	

ZZA-Terracon

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BORING STARTED			5-21-07
BORING COMPLETED			5-21-07
RIG	Volvo	CO.	Boretec
LOGGED	BAG	JOB #	81052367

APPENDIX B
81052367

LABORATORY TESTING PROCEDURES AND RESULTS

A series of laboratory tests were performed during the course of the study to evaluate the index and geotechnical engineering properties of the subsurface soils. Descriptions of the types of tests performed are given below.

Visual Classification

Samples recovered from the explorations were visually classified in the field during the exploration program. Representative portions of the samples were carefully packaged in moisture tight containers and transported to our laboratory where the field classifications were verified or modified as required. Visual classification was generally done in accordance with the Unified Soil Classification System (Appendix C). Visual soil classification includes evaluation of color, relative moisture content, soil type based upon grain size, and accessory soil types included in the sample. Soil classifications are presented on the exploration logs in Appendix A.

Moisture Content Determinations

Moisture content determinations were performed on representative samples obtained from the explorations in order to aid in identification and correlation of soil types. The determinations were made in general accordance with the test procedures described in ASTM D 2216.

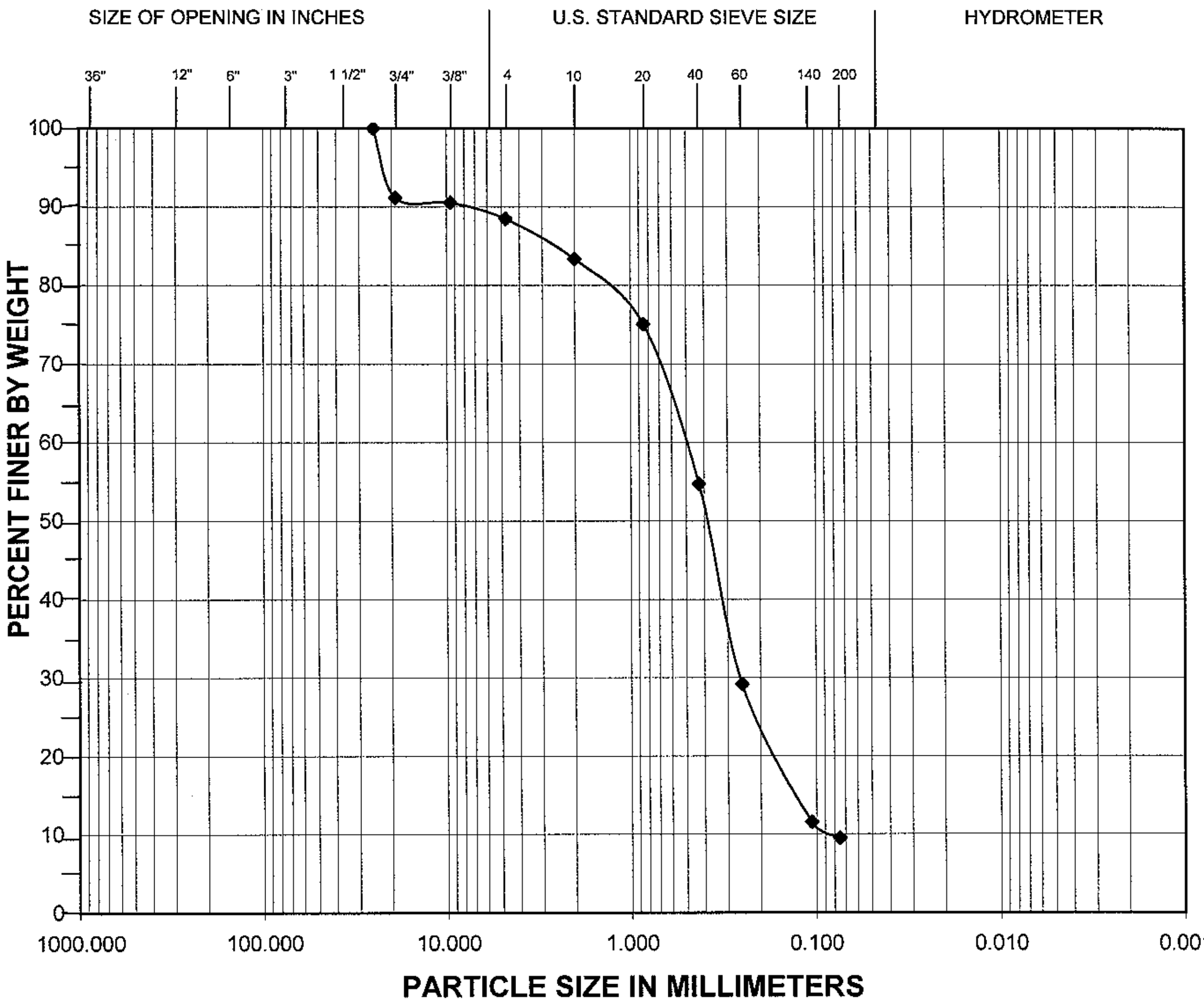
Grain Size Analysis

A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses were performed on representative samples in general accordance with ASTM D 422. The results of the grain size determinations were used in classification of the soils, and are presented in this appendix.

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



BOULDERS	COBBLES	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
		GRAVEL		SAND			FINE GRAINED	

Comments:

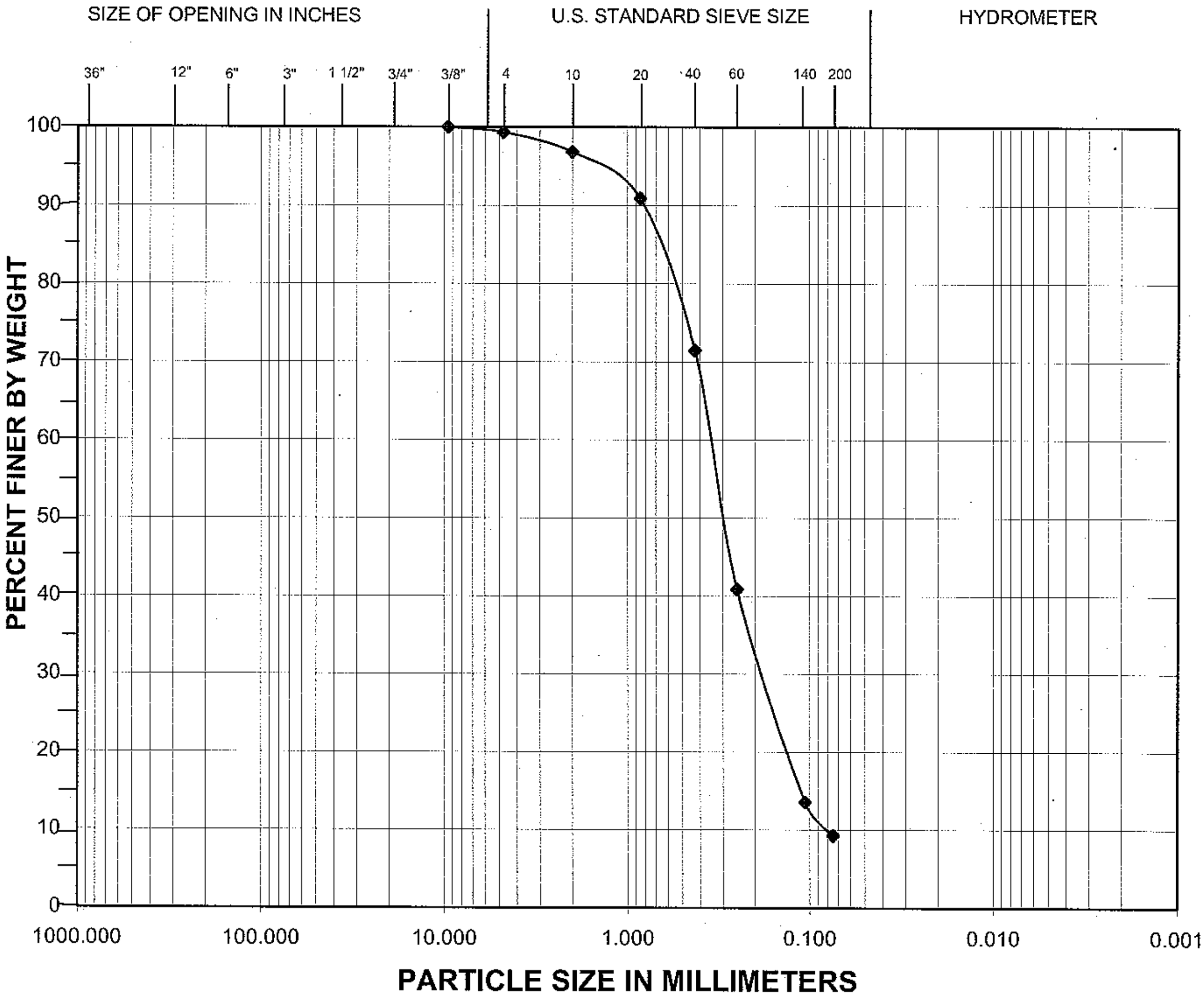
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-1	S-1	5.0	13	9.4	SAND with silt and trace gravel

ZZA Zipper Zeman Associates, Inc. Geotechnical and Environmental Consulting	JOB NO: 81052367 DATE OF TESTING: 6/21/2007	PROJECT NAME: Burke-Gilman Trail

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



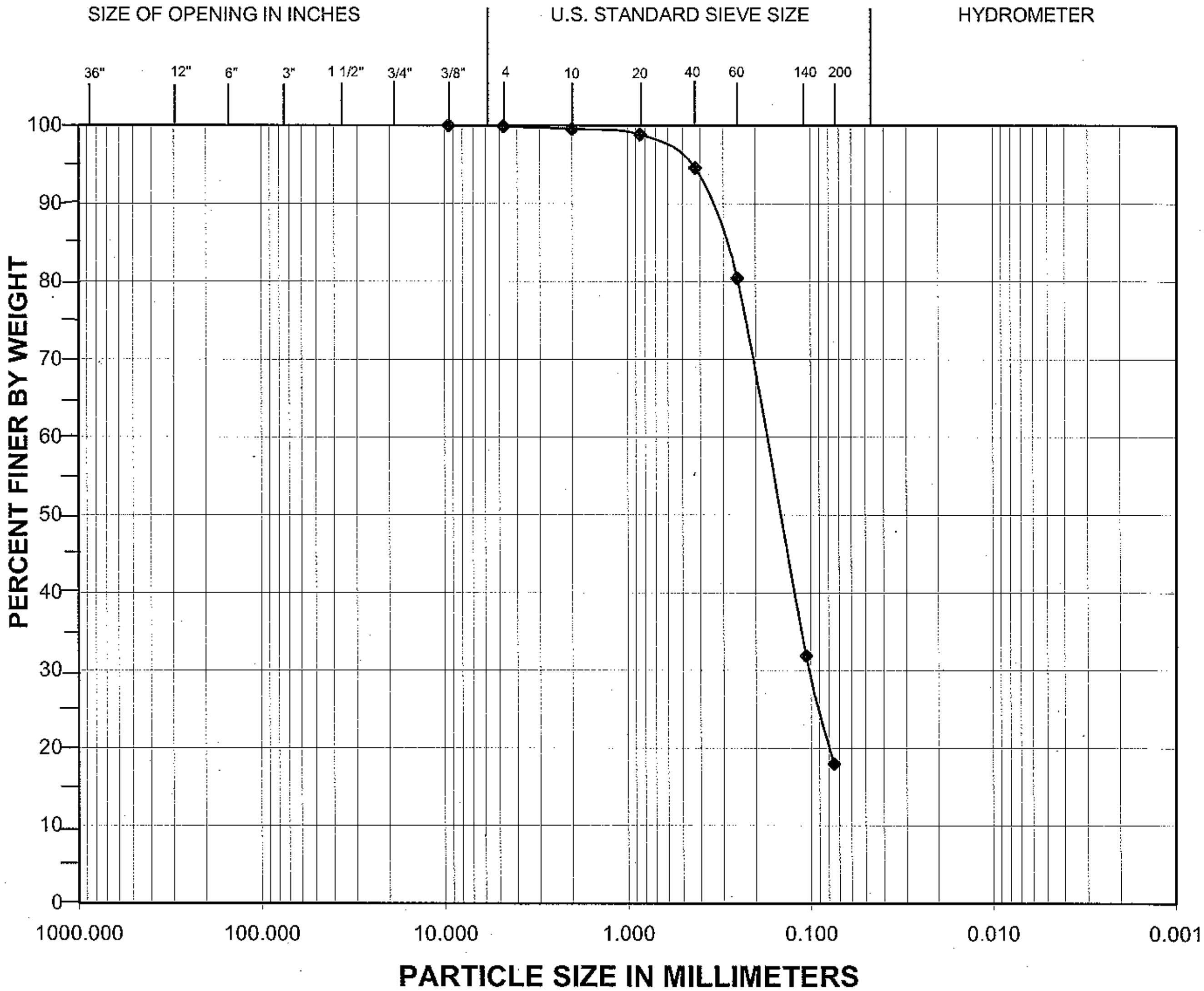
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-1	S-4	20.0	17	9.3	SAND with silt and trace gravel

ZZA Zipper Zeman Associates, Inc. Geotechnical and Environmental Consulting	JOB NO: 81052367 DATE OF TESTING: 6/21/2007	PROJECT NAME: Burke-Gilman Trail

GRAIN SIZE ANALYSIS Test Results Summary ASTM D 422



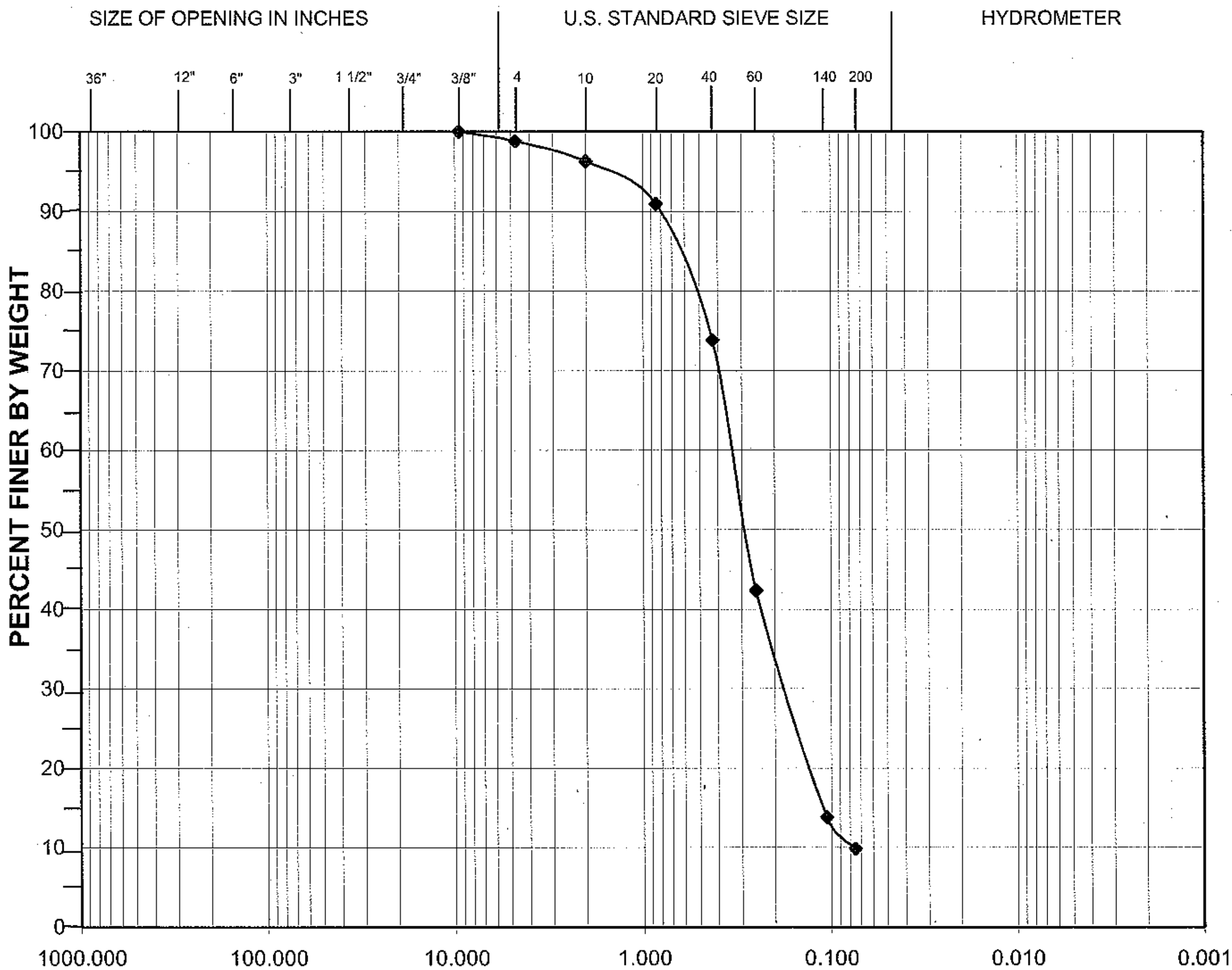
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-1	S-10	50.0	20	18.0	Silty fine to medium SAND

ZZA Zipper Zeman Associates, Inc. Geotechnical and Environmental Consulting	JOB NO: 81052367 DATE OF TESTING: 6/21/2007	PROJECT NAME: Burke-Gilman Trail

GRAIN SIZE ANALYSIS Test Results Summary ASTM D 422



BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-2	S-2	10.0	19	9.8	SAND with silt and trace gravel

ZZA Zipper Zeman Associates, Inc. Geotechnical and Environmental Consulting	JOB NO: 81052367 DATE OF TESTING: 6/21/2007	PROJECT NAME: Burke-Gilman Trail

APPENDIX C
81052367

GENERAL NOTES AND UNIFIED SOIL CLASSIFICATION SYSTEM

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube - 2" O.D., unless otherwise noted	PA:	Power Auger
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB:	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value".

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	N/E:	Not Encountered
WCI:	Wet Cave in	WD:	While Drilling		
DCI:	Dry Cave in	BCR:	Before Casing Removal		
AB:	After Boring	ACR:	After Casing Removal		

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 - 1	Very Soft
500 – 1,000	2 - 4	Soft
1,000 – 2,000	4 - 8	Medium Stiff
2,000 – 4,000	8 - 15	Stiff
4,000 – 8,000	15 - 30	Very Stiff
8,000+	> 30	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 49	Dense
> 50	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	> 30

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifiers	> 12

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	> 30

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UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines Classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay[K,L,M,N]
					Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

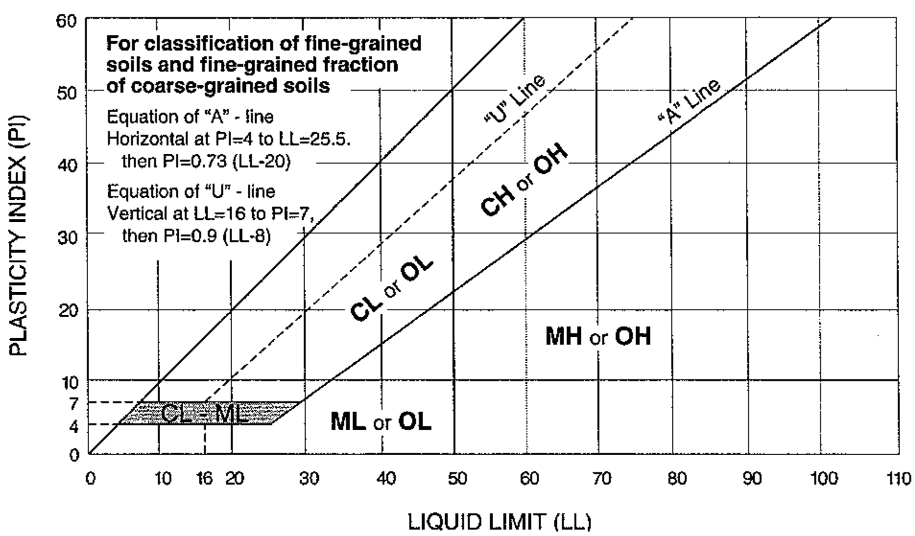
[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI $\geq$ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



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